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71085

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U.S. Department of Transportation, Dockets
Docket No. FAA-1999-6411-10
Seventh Street SW., Room Plaza 401
Washington, DC 20590

Re: Comments to: Transport Airplane Fuel Tank System Design Review, and Maintenance and Inspection Requirements.
Notice of Proposed Rulemaking (NPRM)
Docket No. FAA-1999-6411, Notice No. 99-18

With this letter I like to submit comments to the proposed rulemaking. The comments are submitted by Jack Bergman P.E., on his personal behalf. Jack Bergman is a Consulting Engineer in private practice and is specializing in the fields of Mechanical and Fire Protection Engineering.

The comments pertain to the proposed amendment of paragraph **25.981 "Fuel tank ignition prevention" (c) (1) & (2)** to the airworthiness standards for transport category airplanes, that require means to minimize development of flammable vapors in fuel tanks, or means to prevent catastrophic damage if ignition does occur. This proposed amendment is to apply only to transport category airplane models for which an application for type certification is made **after the effective date of this rule.** This effectively means that the 6000 presently operating aircraft and all new aircraft that will be manufactured in future years, under existing type certifications, are excluded from the proposed requirement to install: "Means to minimize the development of flammable vapors in the fuel tanks" or "Means to mitigate the effect of an ignition within the fuel tanks such that no damage caused by an ignition will prevent continued safe flight and landing".

The proposed rulemaking cites the reasons for the non inclusion of presently operating and future manufactured aircraft in the proposed amendment of Section 25.981 "Fuel tank ignition prevention, (c) (1) & (2)" as the ARAC report that did not recommend specific action to eliminate or significantly reduce the flammability of fuel tanks in current production and existing fleet of transport aircraft, and the fact that at present the FAA has not established the practicality of methods for achieving reduced flammability exposure for newly manufactured and the existing fleet of transport airplanes. The FAA further indicates that rulemaking will be initiated (at some unspecified time in the future) to address these airplanes if practical means are established.

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The present comments propose to include the newly manufactured and the existing fleet of transport aircraft in the amendment of paragraph 25.981 (c) (1) & (2), for the following reasons:

1. While the proposed SFAR addresses the prevention of ignition sources to develop in aircraft fuel tanks, a **second, independent safety system is required,** such as means to minimize the development of flammable vapors in fuel tanks or means to mitigate the effects if an ignition occurs, as required per the FAA advisory circular 25.1309-1A System design analysis, Quote: "A combination of **two or more design principles** is usually needed to provide a fail-safe design (i.e. to insure that catastrophic failure conditions are not expected to occur during the life of the fleet of a particular airplane model)."

2. On completion of the Safety Review, Maintenance Instructions and Airworthiness Directives of the proposed SFAR, the probability of an ignition source present in a fuel tank will be greatly reduced, however as the NTSB stated in Aviation Week & Space Technology of July 20, 1999 relevant to the TWA 800 Probe: Quote: "Whether we identify a specific ignition source is almost irrelevant, for one that we identify, there may be 10 others that have not been engineered out of the tank yet." Indeed, there are new, previously unknown sources of ignition identified frequently, such as the (2) incidents of damaged fuel pumps on Boeing 767 airplanes, (as reported in the NPRM page 58649) in both cases the damage could have caused sparks or hot debris from the pump to enter the fuel tank. This is a recently designed and manufactured aircraft.

3. There are exterior ignition sources over which the aircraft type certificate holder has little or no control, such as an accidental handgun bullet discharge into a flammable tank, when considering the number of safety personnel that carry loaded weapons on some airlines, or Radar ignition hazards as reported in the National Fire Protection Association Standard NFPA 407 " Standard for Aircraft Fuel Servicing, 1996 Edition" that could ignite a flammable mixture in a fuel tank: The beam of radar equipment has been known to cause ignition of flammable vapor-air mixtures from inductive electric heating of solid materials or from electric arcs or sparks from chance resonant conditions. Most commercially available weather-mapping airborne radar equipment operates at peak power outputs of 25 kW to 90 kW. Tests have shown that the beam of this equipment can induce energy capable of firing flush bulbs at considerable distance.

4. The NTSB Recommendations for "Reduced Flammability Exposure" : Following the July 17, 1996 TWA 800 accident the NTSB has issued recommendations to the FAA for the reduction of flammability exposure No. A-96-174 to A-96-177

These recommendation that "Require the development of and implementation of design or operational changes that will preclude the operation of transport-category airplanes with explosive fuel-air mixtures in fuel tanks" are to apply to the current manufactured aircraft and to the existing fleet of transport category aircraft.

5. Aging Aircraft: a large part of the 6000 transport category aircraft that are to be excluded from the application of the amendment to Part 25, paragraph 25.98 1 (c) (10 & (2) are aging aircraft. The co-production aircraft of TWA 800 are now 29 years old, and it is evident that older aircraft are more likely to develop ignition sources due to aging electric wiring, fuel pumping systems, fuel quantity gauging systems and "hot points" resulting from friction of structural parts at points of connection.

6. Time factor: Per the current NPRM, the FAA intends to initiate rulemaking to address these airplanes **if practical means are established** The time required to implement a flammable vapor reduction or mitigation program for the current production and existing fleet of transport airplanes, per the present NPRM, considering the time required by the FAA for research, establishment of the practicality of methods, and the rulemaking process will be quite long, in the order of 3 to 4 years, in our estimate. This period of time has to be looked at in the context of the FAA estimate that between one and two fuel tank explosions would be expected to occur during the next 10 years. Taking the TWA 800, 1996 event as a way point, the probability of an accident prior to the actual implementation of the flammability reduction and/or mitigation for the current fleet of aircraft is quite high.

Discussion of our proposal to include the current production and the existing fleet of transport aircraft in the proposed amendments to Part 25, Section 25.981 (c) (1) &(2)., so that these aircraft are subject to the requirement that their fuel tank installation must include a means to minimize the development of flammable vapors in the tanks., or a means to mitigate the effects of an ignition within the fuel tanks..

The ARAC - FTHWG report concluded that results from thermal analysis indicate that center wing fuel tanks that are heated by air conditioning equipment are flammable on a fleet average basis for up to 30 percent of the fleet operating time. The ARAC report recommended to reduce the flammability exposure of fuel tanks to a maximum of 7 percent of the operational time. However the current production and existing fleet of transport aircraft where not included in this recommendation. The primary reason for the exclusion of these aircraft from the recommendation was the cost and the practicality of the installation of systems to minimize flammability or mitigate ignition in fuel tanks.

While the FTHWG identified a number of available inerting and ignition mitigating systems that are actively used by the military, plus the ground based inerting system that approximately meets the cost/benefit criteria, a recommendation to include the current production and existing fleet aircraft in the provisions for flammability reduction was not made for the above reasons.

This comment proposal submitted to the FAA for review, calls for the inclusion in the present NPRM a requirement for the installation of a Tank Flammability Detection and Alert system (TFDA) in the current production aircraft and the existing fleet of aircraft. The TFDA is intended to significantly reduce the **time transport category airplanes are operating with explosive fuel-air mixtures in the fuel tanks.** The maximum time that fuel tanks will be allowed to operate with flammable conditions in the fuel tanks will be determined by the FAA based on the ARAC recommendation of 7 percent of the operational time or a maximum allowable time frame, or some other time criteria. The installation and operation of a TFDA system in a transport category aircraft, will provide **a second, independent layer of protection** in addition to the ignition sources reduction per the proposed SFAR, thereby providing a significant reduction in the probability that an ignition source will be present **at the same time** that the tank ullage is in the flammable regime. The proposed TFDA is a practical, feasible, time and cost efficient means to reduce the flammability exposure of the current production and existing fleet of aircraft.

(Note: The Tank Flammability Detection and Alert system (TFDA), presented hereunder is a system presently under development by Bergman Consulting Engineers (BCE) and is provided with these comments as an example of a generic system proposed. Other systems of different design concept could possibly perform the same function.)

The TFDA system description: The TFDA is comprised of a fuel temperature sensor, fuel vapor concentration sensor, fuel mist detector (as generated by fuel slosh in the tank), and a central processing unit with its control and display section on the flight deck. The central processing unit (CPU) is in addition connected to inputs from the aircraft altitude pressure indicator, the ambient temperature indicator and the fuel quantity indicator. The CPU will also accept manual inputs of the expected time at ramp, maximum ambient temperature forecast, flash point of the fuel loaded and expected ambient temperature at destination. The TFDA equipment components are of existing aircraft technology, with the exception of the fuel vapor concentration sensor and fuel mist detector. Their principle of operation and function in the TFDA system is explained hereunder: The proposed fuel vapor concentration sensor is a microprocessor based infrared hydrocarbon vapor detector.

Its function in the TFDA system is to detect the actual concentration of fuel vapor in ullage and correlate with the fuel temperature. The proposed fuel mist detector is an opposed beam fiber optics infrared detector that will detect fuel mist traversing the infrared light beam and will provide an analog signal proportional to the intensity of the spray. Its purpose and function in the TFDA system is to provide a measure of the fuel mist present in the ullage of the tank. Fine fuel mist as generated by slosh of fuel in the tank behaves as fuel vapor and adds to the vapor generated by the temperature vapor pressure of the fuel. In order to establish the actual flammability conditions in the tank the measure of fuel mist has to be assessed. For example a fuel tank containing fuel at 90 deg. F that is below the flash point could have mist added at a rate that brings the tank ullage into the flammable range.

Installation and Operation of the TFDA: The TFDA is initially installed in a small number of **lead** aircraft, of each certified aircraft type, that have the same fuel tank system. A data recording device is added to the CPU. Tank flammability data is collected through elevated ambient temperatures at various flight envelopes. At this stage some fuel tanks could be eliminated from the requirement to have the TFDA system installed, like the wing tanks on certain aircraft, as predicted by the theoretical analysis of the FTHWG Report. On completion of this phase, the flammability profiles of the participating aircraft types will be analyzed and **an algorithm** developed for each fuel tank type whose flammability-time characteristics exceed the FAA specified operational limits. These fuel tanks in the respective aircraft type family will be equipped with permanent TFDA systems.

Operation of the TFDA in the fleet:

A. At the gate, the TFDA will indicate to the crew what the actual flammability conditions are in the fuel tanks and will signal an alert if the flammable conditions persisted a longer time than allowed for the type. The TFDA will also provide a **forecast alert** indication of the maximum time allowed at the ramp with passengers at present ambient temperature and fuel loading, until the tanks enter the flammable regime.

B. The TFDA will alert the crew when take-off and climb-out after a specific time at the gate at the present ambient temperature, fuel temperature and fuel loading will cause the fuel tanks to become flammable at a certain altitude and remain in the flammable regime longer than the FAA set standard.

C. The TFDA will alert to any abnormal conditions in fuel temperature, vapor concentration or mist concentration that do not correspond to the normal algorithm of the aircraft type.

D. The TFDA will indicate the flammability conditions in the fuel tanks during the flight and will provide an alert if temperature-altitude pressure and mist combinations cause the fuel tank to reach into the flammability regime.

E. Based on the arrival airport ambient temperature and atmospheric conditions that are keyed in manually or automatically into the CPU, the TFDA will predict if the aircraft fuel tanks will exceed the flammability-time limits during descent, and what the maximum landing-to-gate-to-passenger discharge time is allowed.

The mitigation action that the crew can take to reduce the flammability exposure:

1. Limit the time at gate or unload passengers and shut down the aircraft air conditioning packs.

2. Fill low fuel level tanks with additional fuel to provide an increased heat sink and to cover the fuel pumps and their electric systems.

3. De-fuel hot fuel and re-fuel with cool underground fuel.

4. Limit the time on the ground with passengers on board.

5. Adjust climb out and descent patterns to the minimum flammability exposure to the extent possible.

6. Report and correct any abnormalities in the fuel tank temperature, vapor concentration and mist concentration parameters.

Practicality of the proposed TFDA system: The basic system was tested by BCE in a ground based test tank that provided heating of the fuel, temperature control and a spray capability at the Aerospace Survivability Section of Wright-Patterson AFB, on l/l 2-13/00. The fuel vapor concentration sensor and the fuel mist detector performed satisfactorily. As an example, BCE could furnish a complete working prototype of a TFDA system for ground testing within 3-4 months.

Cost of the TFDA system: While the cost of the components of the TFDA system are readily available, there is a difficulty in estimating the work time and cost required for installation on a particular type of aircraft, without the input for the aircraft manufacturer. Our best estimate at this time without the benefit of input from the aircraft manufacturer is as follows:

Costs are per transport aircraft considering installation in the fleet number of aircraft:

Large wide body transport aircraft:	$ 45,000
Medium transport aircraft:	$ 30,000
Small transport aircraft:	$ 25,000

For further information concerning these comments contact Jack Bergman, P.E.
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I like to thank the FAA for the opportunity and privilege to offer comments to this NPRM.

Sincerely,

Jack Bergman, P.E.